

# Session V: Dirty Bombs and Small Nuclear Devices

(2:00 to 3:00pm)

Overview (15 minutes)

Prof. Paul Fischbeck

Acting Head, Social and Decision Sciences and Professor, Engineering and Public Policy

Evacuate or Shelter in Place – a dirty bomb case study (15 minutes)

Dr. Matt Dombroski, (EPP Ph.D. 2005) Systems and Decision Sciences Section, Lawrence Livermore National Laboratory

Risks of a 10kT terrorist bomb (15 minutes)

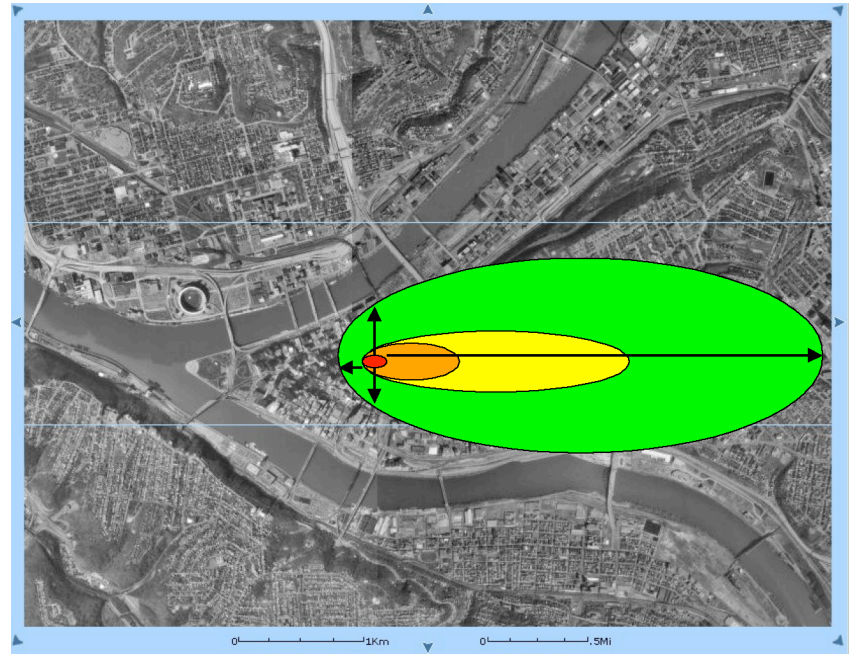
Dr. Keith Florig

Senior Research Engineer, Department of Engineering and Public Policy

Questions and discussion (15 minutes) and then a 15 minute break.

# When are Decisions Hard?

- Large potential costs
- Uncertain outcomes
- Difficult trade-offs
- Conflicting values
- Conflicting advice
- Difficult values to quantify
- Limited resources
- Many interested parties/stakeholders
- Many possible alternatives



Terror-related decisions have all these qualities

# Given a Hard Decision ...

- Despite the research reported in *Science* this week and a recent best seller
  - *On Making the Right Choice: The Deliberation-Without-Attention Effect*
  - *Blink*
- Hard decisions need a systematic approach for exploring alternatives
  - Not only selecting a course of action
  - Understanding the importance of uncertainty
  - Communicating the results

# How Should Alternatives Be Evaluated and Decisions Made?

## Possible decision rules and/or frameworks

- Go with intuition
- Use the “worst case” scenario
- Use multiple scenarios that span the range of “feasible” outcomes
- Adopt the “precautionary principle”
- Classify outcome states using qualitative dimensions
  - Damage (High, Medium, Low)
  - Likelihood (High, Medium, Low)
- Quantitative methods
  - Risk analysis

# An Engineering Definition of Risk

- Stan Kaplan & John Garrick's landmark paper, "On the Quantitative Definition of Risk," was the first paper published in the first issue of the Journal of the Society for Risk Analysis.
- Risk is the set of triplets:  $R = \{(s_i, p_i, x_i)\}$ 
  - $s_i$  What can happen?
  - $p_i$  How likely is it to happen?
  - $x_i$  If it does happen, what are the consequences?
- Risk is multidimensional with many possible damage measures.

# Why Risk Analysis?

- Adopting this formal view of risk helps structure tough decisions
  - But it also brings along some baggage ...
- If you want to reduce risk ...
  - Reduce the likelihood of the initiating event
  - Reduce the negative consequences given that the initiating event has happened
  - Design systems that are resilient or adaptable to the damage
- Space shuttles (Challenger & Columbia) to 9-11 attacks

# When Applied Correctly in a Decision Context ...

- Compare alternative course of actions
- Find the value of gathering more evidence
- Determine robust strategies that reduce substantial amounts of the risk
- Identify and confront the difficult trade-offs
- Opens up the decision process
- Helps communicate justifications for the decision

# Not Infallible

- Garbage in/garbage out
- Quantification of uncertainty
- Valuing difficult future states
- Explicit assessments of trade-offs
- Reliance on “expert opinion”
- Missing scenarios
- People don’t like getting assessed

# Two Terror-Related Nuclear Examples

- Adopting a risk analysis perspective permits evaluation of different risk communication alternatives
  - What should you tell people? When? How? How often?
  - Proper communication could reduce the probability of an event, but most likely it would reduce the negative consequences
- Dirty bomb in an urban area
- Small nuclear device

# Common Elements in Our Approach

- Focus on decisions
  - Emergency response and public officials
  - Individual members of the public
- Merging physical models with behavioral models
- Quantitative models and methods
  - Probabilistic and parametric analyses
- Acknowledging the importance of uncertainty
  - Where is the underlying uncertainty
  - How does it vary across models?
  - Pedigree of data sources

# Motivation: The Need for this Approach

- Several models and studies assess the risk from an radiological dispersion devices (RDD)
  - Hazard Prediction and Assessment Capability (HPAC) and Consequence Assessment Tool Set (CATS) (DTRA, 2004)
  - NARAC iClient (LLNL, 2004)
  - Durante and Manti (2002) and Kelly (2002)
- These models assume that the population is static and they fail to capture:
  - How people may behave during an RDD attack
  - How behavior can impact individual risk assessment
  - As a result, these models don't fully characterize risk from RDDs

# Nuclear Devices in an Urban Setting

- Critical factors for any terrorist incident
  - Communicating the risks to the public
  - Giving them advice with which decisions can be made
- A risk analysis model is critical both beforehand for contingency planning and in real time.
  - Lack of such a model can lead to uninformed or misinformed public that is at considerable greater risk.
  - What suite of models are needed to evaluate various risk communication options?
- The public and their likely behavior
  - Home versus work
  - Panic in the streets

# Compliance with Communication Will Vary

- Accurate risk information doesn't guarantee compliance with recommendations
- Effective risk communication is key to
  - Hearing the message
  - Understanding the message
  - Believing the message
  - Executing the message
- Unintended communication could have be effect
  - Police directing traffic in HazMat suits
  - Neighbors leaving
- Communicating societal trade-offs is tough
  - Slightly increasing risk for some so that others can get big risk reduction

# Radiation Background

- Radioactive decay is the process by which unstable elements become stable elements by releasing energy and/or particles
  - Alpha Particles (Internal Risk)
  - Beta Particles (Internal Risk and Beta Dose to the Skin)
  - Gamma Energy (Internal and External Risk)
- Radioactive energy/particles that is absorbed by the body can interact with cells in the body, disrupting normal function
- Exposure may be reduced through
  - Increased shielding
  - Reduced time of exposure
  - Increased distance from source of radiation

# Discussion

- Health effects from a nuclear attacks
  - Depends highly on the source term
  - Depends highly on people's behavior
- Economic and psychosocial effects will be significant
- What the public chooses to do will depends in large part on what they are told (risk communication)
- Is there a “best” communication? Maybe, but
  - Highly dependent on behavioral model assumptions
  - What is the likelihood that people would understand and comply?
- Good risk management requires careful planning and assessment before a disaster occurs
  - Simulation and analysis of likely scenarios
  - Risk communication analysis
  - Education programs
  - Value of drills